NATIONAL BUREAU OF STANDARDS REPORT

7522

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report for the Period January 1 to March 31, 1962

By
Photometry and Colorimetry Section
Metrology Division

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. Research projects are also performed for other government agencies when the work relates to and supplements the basic program of the Bureau or when the Bureau's unique competence is required. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

Publications

The results of the Bureau's research are published either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three periodicals available from the Government Printing Office: The Journal of Research, published in four separate sections, presents complete scientific and technical papers; the Technical News Bulletin presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: Monographs, Applied Mathematics Series, Handbooks, Miscellaneous Publications, and Technical Notes.

A complete listing of the Bureau's publications can be found in National Bureau of Standards Circular 460, Publications of the National Bureau of Standards, 1901 to June 1947 ($1.25), and the Supplement to National Bureau of Standards Circular 460, July 1947 to June 1957 ($1.50), and Miscellaneous Publication 240, July 1957 to June 1960 (Includes Titles of Papers Published in Outside Journals 1950 to 1959) ($2.25); available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

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NBS REPORT
7522

Development, Testing, and Evaluation of
Visual Landing Aids

Consolidated Progress Report
to
Ship Aeronautics Division
and
Meteorological Division
Bureau of Naval Weapons
Department of the Navy

and to
Federal Aviation Agency
Washington 25 D. C.

For the Period
January 1 to March 31, 1962

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Development, Testing, and Evaluation of Visual Landing Aids
January 1 to March 31, 1962

I. REPORTS ISSUED

Report No.	Title
7419	Performance Criteria for a Two-Color Visual Glide Slope Indicator
21P-43/61 Sup	Photometric Tests of a Semi-Flush Mount Pancake Light, Manufactured by Newport Electronics, Inc.
21P-47/61	Photometric Tests of a Prismatic-Type Flush Deck Guide Light for Aircraft Carriers, Manufactured by the Oxford Corporation.
21P-54/61	Intensity Distribution Measurements of a Condenser-Discharge TV-Tower Light, Manufactured by Kemlite Laboratories, Inc.
21P-63/61	Photometric Tests of a Semi-Flush Mount "Pancake" Light, Manufactured by Strong Electric Corporation.
21P-64/61	Photometric Tests of Retractable Pancake Lights, Manufactured by Stillman Rubber Co.
21P-65/61	Photometric Tests of Two Deck Guide Lights for Aircraft Carriers, Manufactured by Sylvania Electric Products, Inc.
21P-74/61	Photometric Tests of a Semi-Flush Mount Pancake Light, Manufactured by Moloo Drilling Machines, Inc.
21P-78/61	Chromaticity and Photometric Tests of Filters for Visual Glide Slope Equipment
21P-79/61	Photometric Tests of a Night Vision Flood Light Type No. 327, Manufactured by the L. C. Doane Co.
Memo Report	Study of Waveforms of 200-Watt and 45-Watt Series-Series, 6.6/6.6-Ampere, Isolation Transformers.
Letter Report	Film for Fog Simulator

II. VISIBILITY METERS AND THEIR APPLICATION

Slant Visibility Meter. The initial compiling of data from the charts of the slant visibility meter and the associated transmissometers for the past fog season has been completed. These data include those periods when the slant visibility meter was driving and visual comparison observations were obtained and when the projector and detector were stopped in a near horizontal position to obtain information on the correlation of response of the slant visibility meter records and the transmissometer records. The calibration and correction factors have been determined and applied. The data have been tabulated and checked in preparation for further analysis and evaluation of the slant visibility meter. Also the data collected by the Aeronautical Icing Research Laboratories at this site are being copied for possible use in evaluating the performance of this equipment. These data are now ready for a statistical analysis. Preliminary analysis does not reveal a simple relationship between the slant visibility results and transmissometer records or visual observations. An evaluation of the data by a statistician appears desirable.

In the compiling of data and preliminary analysis some problems have been noted. First, the change in sensitivity of the detector frequently creates difficulty in trying to correlate results from the slant visibility meter with transmittance and visual observations. Second, the limit of 110 feet for height of the lights and targets usually means that our visual observations are in the transition zone from conditions at ground level to the more uniform conditions in the fog at greater heights. A higher tower for installation of visibility targets and lights is desirable, but this is not feasible in the vicinity of the airport. Third, there is a need for measurement of vertical transmittance at least up to the height of the measurements and observations.

Shipboard Visibility Meter. Reconstruction of the instrument to correct the deficiencies reported in the previous Progress Report is nearly complete.

The Effects of High-Intensity Airfield Lighting on Background Luminance and Horizontal Illuminance. The draft of this paper has been revised and redrafted following editorial comments. The only major change was in the table on the effects of the increased brightnesses on the effectiveness of the lighting systems. The new table includes the effect of environmental brightness as found at Arcata and at the National Bureau of Standards, Washington, for visibility conditions of 0.5 and 2 miles. For these conditions, the threshold illuminance values, the relative effectiveness per candle output of a single light, and the effectiveness of the system for each intensity setting relative to its effectiveness at the lowest intensity setting are given.

III. DEVELOPMENT OF AIRFIELD LIGHTING AND MARKING COMPONENTS

Taxiway Lighting and Marking. The special lighting of the outline of the runway turnoff(described in the previous Progress Report) has been observed and pilots have been asked for comments. Pilots who have landed here at night in aircraft without landing lights think the light arrangement is excellent. The added lights have been turned out at times in order to find out the pilots' reactions, and some pilots have requested that we put these lights on again. Those pilots who are thoroughly familiar with the arrangement of the field and who have landing lights on their aircraft think the additional lights are helpful but not necessary. Observations from a surface vehicle indicate that the spacing used, which follows BUAER Instruction 11012.1A, seems to be adequate for this particular section of taxiway. The use of double lights spaced five feet apart perpendicular to the runway for marking runway exits seems to be of no special benefit and may actually make the determination of the outline of the taxiway more difficult. The extra lights at these positions could be used better for closer spacing of the lights along the curves. One of the simplest and most useful improvements in taxiway lighting is the placing of a light where the extended centerline of a taxiway crosses the line of taxiway lights at a taxiway end or a sharp turn. This light marks the end of the taxiing direction, serves to help keep the aircraft properly alined, and helps in estimating distances. Additional lights across the ends of taxiways can provide additional guidance, especially if the light on the extended centerline should fail. The proper shielding of taxiway lights should help to reduce the confusion of taxiway edge lights. Further investigation of taxiway lighting will be made during the next quarter.

Approach Beacons. Two approach beacons were prepared for shipment to Federal Aviation Agency's NAFEC for test and evaluation. An approach beacon was also prepared for installation on the approach to runway 13 at the Arcata Airport. This single approach beacon installation is being planned because pilots complain that, while the visual glide slope indicator is very useful on final approach to this runway, the real problem is in determining the position of the end of the runway on the downwind and base legs of the approach. This approach beacon will be located approximately 400 feet ahead of the runway threshold near the edge of a 160-foot bluff. Some years ago a stub approach beacon was planned for this site but had to be abandoned because it interfered with the ILS localizer signal. The localizer antennas have since been moved and are now lower than before. The new beacon will be installed in a pit with only the lamps projecting above the surface of the ground. This beacon installation is intended primarily as a supplement to the visual glide slope indicator. The installation is awaiting weather conditions which will allow the ILS to be turned off to permit work in this area.

Airfield Lighting Maintenance Manual. Tentative plans were formulated for the arrangement of the sections of the Airfield Lighting Manual. Section II will be limited to maintenance of operational types of lights and equipment only. Section I will contain general maintenance information. The descriptions of types of lights will be put into an appendix. Section II will not repeat detailed instructions which are included in appropriate Technical Orders but will refer to the Technical Order where this information can be found.

Cable Test-Detector Set AN/TSM-11. The report on suitable methods and procedures for the use of this equipment and the limitations on its performance will be completed soon.

Modification of Tube Base Adapters (Frangible Couplings). A study is being made of modifications of the design of frangible couplings which will facilitate the removal of the threaded part of the coupling after the top of the coupling has been sheared off. Couplings prepared with milled slots on the outside were checked for ease of removal from a floor flange after the upper portion had been broken off. This design was not satisfactory in that with the slots on the outside the small section being broken out would bind very tightly and had to be hammered on very hard. Another adapter was modified with a single notch cut on the inside using three blades side by side in a hacksaw frame. The notch was not cut to the threads. It only required moderate blows with a hammer to break a piece out and the rest was easy to remove. This modification will make the adapter easily removable and will not reduce the effective strength significantly.

Visual Glide Slope Indicators. A visual glide slope indicator was received from the FAA and installed on the outdoor range. Several sets of spread lenses have been received and will be used to compare the visual transition zones associated with spread lenses of the following types: a) near the pale limit of aviation red; b) somewhat darker than the darkest filters meeting the requirements of aviation red; c) standard clear spread lenses; and d) spread lenses which increase the color temperature of the clear segment to about 4000°K. Several observers will be used to determine statistically whether a specified angle of the indicator produces a red, white, or pink indication. Photometric measurements of the several spread lenses have been started, using the VGSI simulator and the attic range. The lenses will be compared as to their beam spreads and transmission ratios.

Intensity Distributions of a DCB-10 Beacon. Testing was begun on a modified DCB-10 beacon which has been in use on a TV tower in Madison, Wisconsin. The unit had been modified to use the 1200-watt airport beacon lamp. The effective intensity distribution of the light will be computed.

Intensity Distributions of a Condenser-Discharge TV-Tower Light. NBS Test Report 21P-54/61 was issued giving the results of intensity distribution measurements made during the quarter of a developmental condenser-discharge TV-tower light manufactured by Kemlite Laboratories, Inc., Chicago, Ill. The unit produced a peak effective intensity of 7200 candles and a mean vertical beam spread at 3600 candles of 23.5°.

Intensity Control of Shore-Based Optical Landing System. The transformers required to provide continuous adjustment between the steps of the present intensity control (see previous Progress Report) have been received and delivered to the Naval Air Test Center. A practical wiring diagram of the intensity control has been modified to show the method of connecting these transformers into the system.

IV. DEVELOPMENT OF SEADROME LIGHTING COMPONENTS

No work was done in this field during the quarter.

V. DEVELOPMENT OF CARRIER LIGHTING AIDS (TED NBS RSSH-32001)

Intensity Distributions of a Prismatic-Type Flush Deck Guide Light. Intensity distribution measurements were made of a No. 4010 flush deck guide light for aircraft carriers, manufactured by The Oxford Corporation, Buffalo, New York. The performance of the unit was below the specified minimum of the contract under which it was made at four of the seven angles of traverse used in the test. An adjustment of the prism could bring the unit into compliance with the requirements. There was a large amount of "leakage" light in the near-vertical direction that should be corrected. NBS Test Report 21P-47/61 was issued.

Intensity Distributions of Two Deck Guide Lights for Aircraft Carriers. Intensity distribution measurements were made of two prototype deck guide lights for aircraft carriers, manufactured by Sylvania Electric Products, Inc. The units were designated as: (1) class 1, incorporating a molded lens and a Type 6.6A/T-3Q/1CL 100-watt lamp and (2) class 2, with a Type 6.6A/T-2-1/2Q/1CL 45-watt lamp, but with no optical components. Neither unit met the requirements of the purchase description with regard to the beam elevation requirements. The class 2 unit met the photometric requirements while the class 1 unit did not. NBS Test Report 21P-65/61 was issued.

Intensity Distribution Measurements of a Night-Vision Flood Light. Intensity distribution measurements were made of a night vision flood light type no. 327, manufactured by the L.C. Doane Co., Essex, Connecticut. NBS Test Report 21P-79/61 was issued.

Stabilization of Shipboard Optical Landing System. The draft of a report "Derivation of roll and pitch correction factors for the point in space stabilization..." was reviewed critically. There were no differences in the equations developed in this report and equations derived at NBS when allowance is made for the differences in definitions.

High-Low Cells. Arrangements are being made to mount a lens-type optical landing system with High-Low cells attached on the roof on the East Building of the National Bureau of Standards so that the system can be observed and studied from a distance.

VI. PHOTOMETRIC AND ELECTRICAL TESTS OF AIRFIELD AND SEADROME LIGHTING COMPONENTS. (TED NBS SI-5003)

Lamps for Two-Color Visual Glide Slope Indicators. Life testing of the two groups of off-focus PAR-64 lamps for use in the two-color VGSI was suspended when it was learned that one of the groups being tested was no longer representative of the lamps being furnished by that manufacturer for use in the indicators. Two new groups of lamps were requisitioned and the life testing will be resumed when the lamps arrive.

"Pancake Lights." Four NBS Test Reports were prepared and issued covering intensity distribution measurements made of semi-flush mount pancake lights, as follows:

21P-43/61 Sup.	Newport Electronics, Inc.
21P-63/61	Strong Electric Corporation
21P-64/61	Stillman Rubber Co.
21P-74/61	Molco Drilling Machines, Inc.

Insulation Resistance Tests on a "No. 18047 Line-Up Guide Light." Tests were made of the insulation resistance on a No. 18047 Line-Up Guide Light manufactured by Structural Electric Products Corporation, Windsor Locks, Connecticut. The unit is intended to be welded to a carrier deck. The resistance measurements of the unit were satisfactory; the unit was tested dry and following an overnight soak in tap water. Letter Report 21P-23/62 was issued.

Intensity Distribution Measurements of a Prismatic-Type Approach and Runway Light. NBS Test Report 21P-2/62 was drafted giving the results of intensity measurements made during the quarter of a prismatic-type approach and runway light manufactured by Multi Electric Manufacturing, Inc., Chicago, Illinois. The unit projects 1/2 inch above the runway and, therefore, comes under the provision of the BB-2 or BB-5 lights of Specification MIL-L-26202B.

The unit did not meet the beam elevation requirements for either type. The unit was tested with the lamp furnished with it (6.6A/PAR56/3, 200-watt) and also with a similar lamp which had been previously used in NBS Test 21P-23/61, and which was taken as a "control" lamp. The uncertainties of testing units lamped with PAR type lamps were pointed up by the results of the tests: the unit met the specification requirements with the lamp furnished, but not with the control lamp. Some work was done with several 6.6A/PAR56/3 lamps, with a view to obtaining data that would prove helpful in either improving the specification or fitting the testing to the existing specifications.

Airfield Lighting Connectors. Leakage current measurements were made and a preliminary report is being prepared of results to date.

Performance Criteria for a Two-Color Visual Glide Slope Indicator. Comparison tests were made of the effects of lamp characteristics on the photometric performance of a simulated R.A.E.-type Visual Glide Slope Indicator (VGSI). The results of this study were published in NBS Report 7419, which also includes a procedure for alining lamps in the VGSI and specification criteria based on data previously issued in NBS Reports 21P-8/61, 21P-31/61, and 21P-36/61.

Lamp Characteristics. A supplement is being prepared for NBS Report 6190, Current-Intensity, Voltage-Intensity, and Current-Voltage Characteristics of Airfield Lighting Lamps, which was issued in October 1958. Measurements have been made of the characteristics of lamps developed since the report was issued.

Output Maintenance of Sealed-Reflector Lamps. Measurements are being made of the output maintenance characteristics of 200-watt, 6.6-ampere, PAR 56 approach light and runway light lamps. Measurements are being made periodically both of complete lamps and selected zones of the lamps. Similar measurements of 20-ampere lamps have been completed.

Waveforms of 45- and 200-watt, 6.6-Ampere Isolating Transformers. Studies of the wave forms of 6.6-ampere airfield lighting transformers have been completed and a memorandum report issued. When the transformers were connected into a circuit supplied by a 4-kilowatt regulator, the open circuit voltage of the 45-watt transformer was 288 volts peak-to-peak and that of the 200-watt transformer was 775 volts peak-to-peak.

Tests of Cable Connectors. Tests have been completed of fused connectors and two-conductor plug connectors supplied in kit form and manufactured by Elastimold Division of ESNA. There were no significant deviations from specification requirements except that the separating forces were high.

Filters for Visual Glide Slope Indicators. Tests of chromaticity and beam spread of filters for VGSI units have been completed and reported in NBS Test Report 21P-78/61. The filters did not meet the requirements for chromaticity or beam spread.

VII. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

Review of Specifications and Drawings. The technical sections of the following specifications and drawings were reviewed and the comments have been forwarded.

MIL-L-26202C, Light, Flush Approach, Runway, and Taxiway

MIL-C-4921A, Cable, Power, Electrical, Airport Lighting, General Requirements for

Indicator Systems, Glide Slope, Optical, Trailer-Mounted, Shore-Based

Cable Clamp Assembly Drawing

Frangible Coupling Drawing

Tube-Base Adapter, Runway Marker Light, Drawing.

Fog Simulator. Measurements of the densities of sample fog screens for the airborne fog simulator have been completed and equivalent visual ranges computed. The results have been reported by letter to the contractor. A visit was made to NAFEC to participate in field tests of the screens and conferences related thereto.

ICAO Activities. Meetings of the SAGA planning committee and working groups developing material for the U.S. position for the VAS and AGA meetings have been attended and pertinent documentary material has been prepared.

Guide to Photometric Procedures. NBS Report 7410 "A Survey of the Equipment and Procedures for the Photometry of Projectors at the National Bureau of Standards" has been completed and is being duplicated. The object of this report was the description of the procedures used and equipment available. Besides serving as a guide, the report will make unnecessary a detailed description of procedures in future NBS test reports.

VIII. MISCELLANEOUS

Aeronautical Icing Research Laboratories. The AIRL group at Arcata had planned to move to Vandenberg AFB this spring, but now plans to remain at Arcata at least until September. We are making copies of the data which this group obtained during the past fog season for possible use in our work.

Weather Bureau. The Weather Bureau is planning a runway visual range instrumentation installation for the Arcata Airport soon. A 500-foot baseline transmissometer will be installed near the ILS glidepath shelter. A 400-foot baseline and a 1200-foot baseline rotating-beam ceilometer installation is planned for the area near the middle marker and towards the runway. They hope to have this installation completed before the fog season starts.

Visual Glide Slope Indicator. The FAA visual glide slope indicator installation at Arcata was inspected and discussed with the FAA personnel and pilots. The red spread lenses used in this installation were of two different shades with a considerable difference in transmission. The pilots remarked that the intensity of these units is greater than they had expected. They feel, however, that an additional visual aid is needed to supply guidance on the down-wind and base legs of the approach pattern.

Lighting Malfunction at the Rhonerville Airport. The Humboldt County Department of Aviation experienced intermittent failure of the runway lights at the Rhonerville Airport and the cause of this failure was difficult to locate. The circuit would check out as having continuity and the lights would operate except on occasions after the regulator had been de-energized. The circuit had practically no insulation resistance to ground. As was expected the fault occurred from an intermittent opening in the cable, caused by gophers gnawing through the insulation and nearly through the conductor. Many other examples of damage to direct-burial cable from gophers were obtained.

U. S. DEPARTMENT OF COMMERCE
Luther H. Hodges, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D. C.

Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Polymers. Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research.

Metallurgy. Engineering Metallurgy. Microscopy and Diffraction. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition.

Inorganic Solids. Engineering Ceramics. Glass. Solid State Chemistry. Crystal Growth. Physical Properties. Crystallography.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

Data Processing Systems. Components and Techniques. Computer Technology. Measurements Automation. Engineering Applications. Systems Analysis.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Solid State Physics. Electron Physics. Atomic Physics.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Molecular Kinetics. Mass Spectrometry.

Office of Weights and Measures.

BOULDER, COLO.

Cryogenic Engineering Laboratory. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Cryogenic Technical Services.

CENTRAL RADIO PROPAGATION LABORATORY

Ionosphere Research and Propagation. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

Radio Propagation Engineering. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

Radio Systems. Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems.

Upper Atmosphere and Space Physics. Upper Atmosphere and Plasma Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

RADIO STANDARDS LABORATORY

Radio Physics. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Millimeter-Wave Research.

Circuit Standards. High Frequency Electrical Standards. Microwave Circuit Standards. Electronic Calibration Center.


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